

01/18/00  
U.S. PTO  
85 U.S. PTO

EVENSON, MCKEOWN, EDWARDS & LENAHAN, P.L.L.C.  
1200 G Street, N.W., Suite 700  
Washington, D.C. 20005  
(202) 628-8800

January 18, 2000

jc511 U.S. PTO  
09/484421  
01/18/00

**Box PATENT APPLICATION**

Assistant Commissioner for Patents  
Washington, D.C. 20231

Re: New U.S. Patent Application  
Our Ref: 622/48561

Sir:

Transmitted herewith for filing is the patent application of:

Martin Dubs et al.

entitled: SPUTTER CHAMBER AS WELL AS VACUUM TRANSPORT CHAMBER  
AND VACUUM HANDLING APPARATUS WITH SUCH CHAMBERS

Enclosed are:

1. German Specification, including 34 claims (28 pages).
2. 9 Sheets of        Formal xx Informal drawings  
showing Figs. 1 - 10
3. X Declaration and Power of Attorney (**unexecuted**).

The filing fee is being deferred.

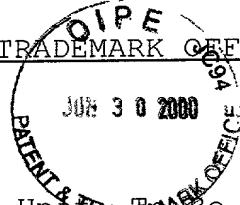
Respectfully submitted,

  
Donald D. Evenson  
Registration No. 26,160

DDE:rcs

Attorney Docket: 622/48561  
PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE



Applicant: MARTIN DUBS ET AL.

Serial No.: 09/484,421 Group Art Unit ~~TRADEMARK~~ Be Determined

Filed: JANUARY 18, 2000 Examiner: Not Assigned

Title: SPUTTERING CHAMBER AS WELL AS VACUUM TRANSPORT CHAMBER  
AND VACUUM TREATMENT SYSTEMS HAVING SUCH CHAMBERS

**PRELIMINARY AMENDMENT**

**Box Amendments**

Commissioner for Patents  
Washington, D.C. 20231

June 30, 2000

Sir:

Please enter the following amendments to the specification  
prior to the examination of the application.

**IN THE SPECIFICATION:**

Attached is a Substitute Specification and a marked-up copy  
of the original specification.

**ABSTRACT**

Please enter the Abstract submitted herewith on a separate  
page for the original Abstract presently in the application.

If necessary to effect a timely response, this paper should be considered as a petition for an Extension of Time sufficient to effect a timely response, and please charge any deficiency in fees or credit any overpayments to Deposit Account No. 05-1323 (Docket #622/48561).

Respectfully submitted,

  
\_\_\_\_\_  
James F. McKeown  
Registration No. 25,406

EVENSON, McKEOWN, EDWARDS  
& LENAHAN, P.L.L.C.  
1200 G Street, N.W., Suite 700  
Washington, DC 20005  
Telephone No.: (202) 628-8800  
Facsimile No.: (202) 628-8844

JFM:sbh

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

**SUBSTITUTE SPECIFICATION**

**INVENTION:**

**SPUTTERING CHAMBER AS WELL AS VACUUM  
TRANSPORT CHAMBER AND VACUUM TREATMENT  
SYSTEMS HAVING SUCH CHAMBERS**

**INVENTOR:**

Citizenship:

Residence/

Post Office Address

**Martin DUBS**

Swiss

Im unteren Stieg

CH-7304 Maienfeld

SWITZERLAND

**INVENTOR:**

Citizenship:

Residence/

Post Office Address

**Roman SCHERTLER**

Austrian

Lorenz Schertlerstrasse 18

A-6922 Wolfurt

AUSTRIA

**ATTORNEYS:**

**EVENSON, McKEOWN, EDWARDS & LENAHAN, P.L.L.C.**

Suite 700

1200 G Street, N.W.

Washington, D.C. 20005

Telephone No.: (202) 628-8800

Facsimile No.: (202) 628-8844

#4

**SPUTTERING CHAMBER AS WELL AS VACUUM TRANSPORT CHAMBER AND VACUUM  
TREATMENT SYSTEMS HAVING SUCH CHAMBERS**

**BACKGROUND OF THE INVENTION**



The present invention relates to a sputtering chamber having  
5 at least one sputtering source with a new sputter surface at  
least approximately symmetrical with respect to a central axis,  
[further having] and a substrate carrier which is rotatable in a  
driven manner about a substrate carrier axis[, the]. The central  
axis and the substrate carrier axis [being] are oblique with  
respect to one another[, according to the preamble of Claim 1].

Furthermore, the present invention relates to a vacuum  
treatment system having [such a] the above-mentioned sputtering  
chamber [according to the preamble of Claim 16], a vacuum  
transport chamber for disk-shaped workpieces [according to that  
of Claim 17], and finally a vacuum treatment system having [such]  
a vacuum transport chamber [according to the preamble of Claim  
29].

[From] U.S. Patent [Documents US] Nos. 4,818,561 [as well as  
US] and 4,664,935[,] describe conventional sputtering chambers[  
20 of the initially mentioned type are known]. The central axis of  
the sputtering source is arranged at an oblique angle with  
respect to an axis of rotation of a substrate carrier. The

substrate carrier is rotated in a driven manner about the substrate carrier axis. [By means of] With this sputtering chamber, coating uniformities of better than  $\pm 4\%$  are achieved on wafers, whose diameters may be up to 200 mm.

5        During the manufacturing of storage disks, particularly of optical storage disks, such as mini floppy disks or CDs; further, during the manufacturing of masters, but also for the manufacturing of piezoelectric wafers, of wafers for the production of semi conductors, in this case, particularly also for wafers for the implementation of SAW's (Surface Acoustic Waves), it is extremely important to reach a uniform layer thickness distribution which is at least equally good as, if not better than, that which can be achieved [by means of] with the [above-described] known sputtering chambers. In addition, the coating rates should be as high as possible in order to achieve coating times which are as short as possible and thus production rates which are as high as possible.

10      15

#### SUMMARY OF THE INVENTION

20       It is an object of the invention to suggest a sputtering chamber of the initially mentioned type by means of which, while the coating rates are increased, layer thickness homogeneities

can be achieved which are even better than those achievable by means of the known sputtering chambers.

This [is] object has been achieved, according to the present invention, by [means of the implementation of the] providing an improved sputtering chamber [of the invention according to the characterizing part of Claim 1], specifically [in that] one in which the sputtering source is a magnetron sputtering source.

While, in [the case of] a conventional sputtering source, the sputtering surface of the target is removed essentially uniformly, the situation is completely different [in the case of] with magnetron sputtering sources. Because of the tunnel-shaped magnetic field which is inherent to the magnetron sputtering sources, is built up over the sputtering surface of the target and is closed in itself, a surrounding erosion trough is formed on the sputtering surface. [which] The erosion trough, as the sputtering-off time increases, varies the direction characteristic of the sputtered-off target material. If several tunnel fields are provided, surrounding erosion troughs may be formed.

Although magnetron sputtering sources result in higher sputtering-off rates and thus also higher coating rates than

conventional sputtering sources, they are much more critical with respect to the achievable uniformity of the layer thicknesses.

It is therefore even more astonishing that [by means of] with the use according to the invention of a magnetron sputtering source

5 at the sputtering chamber according to the invention, not only a  
higher coating rate can be achieved and thus shorter coating  
times, but also coating thickness uniformities are achieved which  
are at least as good as and even significantly better than those  
achievable [by means of the initially mentioned] with  
10 conventional sputtering chambers[ according to the above-  
indicated documents].

[Preferred embodiments of the sputtering chambers according to the invention are specified in Claims 2 to 15.]

15 It is another object of the present invention to integrate the above-mentioned sputtering chamber according to the invention into a vacuum treatment system such that, in an automated manner, the fast coating times, which can be achieved by [means of] the sputtering chamber according to the invention, can also be utilized to their full extent. This is achieved by [means of 20 the] a vacuum treatment system [according to Claim 16; that is, as the result of the fact that] in which the above-mentioned sputtering chamber is connected by way of one or several

transport chambers with at least one lock chamber, at which substrates are transferred inward from the surroundings into the vacuum or are transferred outward from the vacuum into the surroundings.

5        Furthermore, [according to Claim 17,] a vacuum transport chamber is suggested which is conceived particularly for short transport cycles, which is inventive per se and which[, according to Claims 29 and 30,] can be ideally combined with the sputtering chamber according to the invention to form a vacuum treatment system with extremely short transport cycles and, in addition, particularly in preferred embodiments of the transport chamber according to the invention, leads to extremely short inward-transfer and outward-transfer cycles of substrates to be coated and coated substrates.

10        [Preferred embodiments of the vacuum transport chamber, which also separately corresponds to the invention, are specified in Claims 18 to 28. Preferred embodiments of the vacuum treatment system according to the invention having such a transport chamber are specified in Claims 29 to 32.

Furthermore, the present invention relates to a process for manufacturing coated data storage disks or wafers according to Claim 34.]

5 The sputtering chamber and the transport chamber according to the invention as well as the systems according to the invention are suitable particularly for the coating of optical data storage substrates as well as masters for the manufacturing of such optical data storage disks or of piezoelectric wafers or wafers for the production of semiconductors.

10 **BRIEF DESCRIPTION OF THE DRAWINGS**

Other objects, advantages and novel features of the present invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings.

15 Figure 1 is a schematic view of a sputtering chamber according to the invention;

[Figure 2 is] Figures 2a and 2b are [a] top [view] views of a substrate carrier arrangement, as provided on the sputtering

chamber of Figure 1 according to the invention, for defining the relationships with respect to substrates deposited thereon;

Figure 3 is a schematic view of the arrangement of the substrate carrier and the magnetron sputtering target on a sputtering chamber according to the invention for defining the mutual geometrical position relationships;

Figure 4 is a representation [analogous] similar to Figure 1 of a sputtering chamber according to the invention but having a double magnetron source;

Figure 5 is a schematic view of another currently preferred embodiment of the sputtering chamber according to the invention, in [the case of] which a process space is partitioned off;

Figure 6 is a schematic [lateral and partially broken] side view of a vacuum treatment system according to the invention with a sputtering chamber according to the invention, [as an embodiment] shown in partial cross-section;

Figure 7 is a top view of a vacuum treatment system according to the invention basically constructed [like] similar

to the system [according to] of Figure 6, but having several treatment stations and an inlet/outlet lock;

5 Figure 8 is a partially simplified view of a transport chamber according to the invention, combined with a sputtering

chamber according to the invention for forming a vacuum treatment system of a preferred construction according to the invention;

10 Figure 9 is a top view of the transport chamber [according to Figure 8 corresponding to the intersection Line] along line II-II of Figure 8[,]; and

15 Figure 10 is a [view] graph of layer thicknesses removed along the substrate radius as the result of described coating experiments.

#### DETAILED DESCRIPTION OF THE DRAWINGS

Figure 1 [is a schematic view of] shows a sputtering chamber [according to the invention. It comprises] having a magnetron sputtering source 1. The tunnel-shaped magnetron magnetic field H which is closed in itself and extends around the central axis Z of the source 1 is schematically illustrated above the sputtering surface 3 of a [(not shown)] target arrangement of the magnetron

sputtering source 1. In the top view, that is, viewed in the direction of the central axis Z, the sputtering surface 3 of the magnetron source 1 may have a rectangular, square, elliptical design etc., but is preferably rotationally symmetrical with respect to the central axis Z. However, the central axis Z is definitely situated in a plane of symmetry of the sputtering surface 3 viewed in the top view. Furthermore, the sputtering surface, in its new condition, called a new sputter surface, may at least essentially be [plane] planar or define a concave surface. A single tunnel-shaped magnetic field H may be provided which is closed in itself and extends around the central axis Z, or two or more fields may be provided.

In addition, the one or several provided magnetron fields H, which are closed in themselves and extend around the central axis Z, may be constructed in a steady-state manner or in a varying manner with respect to time, as, for example, by providing moving magnet arrangements below the target arrangement with permanent magnets and/or solenoids or, generated by solenoids which are selectively triggered with respect to time.

With reference to Figure 1, the sputtering chamber according to the invention has a substrate carrier 5 which, in a driven manner - 6 - is rotationally movable about a substrate carrier

axis A. The substrate carrier 5 is constructed such that it can accommodate an individual substrate 7 (Figure 2a), preferably centered with respect to the substrate carrier axis A, or it can accommodate several substrates 7a, preferably also in a centered manner, (Figure 2b). In this case, the one substrate 7 or also the several substrates 7a can definitely overlap the substrate carrier 5, as illustrated in [Figure 2] Figures 2a and 2b at 7' and 7a'.

[When] In the following description, the diameter  $\varphi_s$  [is mentioned in the following, this value] indicates either [-] the substrate diameter according to Figure 2a, or [-] the diameter of the outer substrate boundary line according to Figure 2b.

On the sputtering chamber according to the invention, differently shaped substrates, like square or rectangular substrates, can definitely also be sputter-coated.

The magnetron sputtering process can take place in a reactive or non-reactive manner, and the magnetron sputtering source DC, DC+AC, can be operated with pulsed DC or with pure AC, in which case AC can be chosen up into the HF-range.

The central axis Z and the substrate carrier axis A are oblique with respect to one another. They do not necessarily intersect one another.

For this reason, in the following only a - partially  
5 preferred - special case of the "intersection point" of both axes Z, A is addressed; more generally, the "site of the smallest spacing" of the two axes is mentioned.

When the angle  $\beta$  is addressed which the axes Z and A take up  
10 with respect to one another, in the case of inclined axes, this angle is determined in that one axis is displaced in parallel until both axes are situated in a plane. This results in the angle  $\beta$  in this plane.

However, in a preferred embodiment, as [entered] shown in  
15 Figure 1 at point P, the central axis Z of the source 1 and the substrate carrier axis A intersect at least almost.

Irrespective of whether the two mentioned axes Z and A intersect or are inclined with respect to one another, they definitely preferably enclose an angle  $\beta$ , to which the following applies:

20  $30^\circ \leq \beta \leq 60^\circ$ ,

preferably

$$40^\circ \leq \beta \leq 55^\circ,$$

particularly preferably

$$43^\circ \leq \beta \leq 50^\circ,$$

5 in this case, extremely preferably an angle  $\beta \approx 45^\circ$ .

When this angle  $\beta$  is precisely maintained, the uniformity of the thickness of the deposited layer is optimized.

As schematically illustrated in Figure 3, the site L of the shortest distance between the central axis Z and the substrate carrier axis A is preferably situated at least approximately on the center of the substrate carrier 5, in this case, preferably on the surface to be coated of a [-] centered [-] substrate 7, 7'.

15 The sputtering source according to the invention can be arranged in the space in an arbitrarily oriented manner.

As further illustrated in Figure 3, the projection of the substrate surface onto a plane  $E_z$  perpendicular to the central axis Z is preferably smaller than the projection of the new sputter surface onto this plane  $E_z$ .

Figure 3 qualitatively shows the erosion trough 15 which forms during the operation on the sputtering surface and extends around the central axis Z, or a second erosion trough 15a, when two surrounding tunnel-shaped magnetic fields, which are closed in themselves, are implemented.

With respect to the central axis Z,  $r_{tr}$  indicates the radius of the site of the largest erosion depth of the radially outermost erosion trough 15.

In a preferred embodiment of the sputtering chamber according to the invention, the following ratio is obtained between this radius  $r_{tr}$  and the distance D between the new sputter surface and the site L or between the new sputter surface and the substrate carrier 5

$$1/4 \leq r_{tr} / D \leq 2/3.$$

Furthermore, the following preferably applies according to Figure 3 to the diameter  $\phi_T$  of the projection of a rotationally symmetrical new sputter surface onto the plane  $E_z$  and the mentioned distance D

$$3/4 \leq \phi_T / D \leq 2,$$

in this case, particularly the following applies

$$\phi_T \approx 1.2 D.$$

With respect to the diameter  $\varphi_s$  (see definition above), with respect to the above-mentioned distance D, the following preferably applies

$$\varphi_s / D \leq 1.8.$$

5 Furthermore, the following preferably applies in a preferred embodiment with respect to the above-mentioned diameter  $\varphi_s$  and the above-mentioned sputtering surface diameter or sputtering surface projection diameter  $\varphi_T$

$$0.5 \leq \varphi_s / \varphi_T \leq 2.4.$$

10 preferably

$$1 \leq \varphi_s / \varphi_T \leq 2.4.$$

15 Particularly in the case of axes Z and A which, as illustrated in Figure 3, intersect at least approximately, the indicated dimensioning rules result in an optimal utilization of the material sputtered off the target 4 with respect to the material placed on the substrate or substrates, specifically of at least 10%. In this case, layer thickness deviations along the coated substrate surfaces of no more than  $\pm 1\%$  are reachable without, particularly on a plane round target, special measures 20 having to be taken with respect to the formation of the erosion troughs.

In addition, the above-mentioned dimensioning rules lead to the following advantages:

[-] minimal sensitivity of the resulting uniformity of the layer thicknesses to variations of D and thus also to the

5 increasing erosion of the target in the course of its service life;

[-] minimal sensitivity of the uniformity of the layer thicknesses to changes of the erosion profile or profiles;

10 [-] minimal sensitivity of the uniformity of the layer thicknesses to positioning errors of the substrate or substrates on the substrate carrier 5.

In a particularly preferred embodiment the following applies:

$$50 \text{ mm} \leq \varphi_s \leq 400 \text{ mm},$$

15 in this case, preferably

$$50 \text{ mm} \leq \varphi_s \leq 300 \text{ mm},$$

particularly preferably and particularly used for individual substrates in a centered manner with respect to the substrate carrier axis A, diameter  $\varphi_s$  of 64 mm (particularly for mini floppy disks), 120 mm (particularly for CDs), 160 to 240 mm (for CD masters). For the highly precise depositing of layers on piezoelectric wafers, the substrate holding device is preferably [designed] sized for substrate diameters of at least 75 mm; for

the treatment of wafers for the semiconductor production for the receiving of wafers, it is [designed] sized with diameters of between 150 and 300 mm.

As schematically illustrated in Figure 4, two or more sources 10a, 10b, of which at least one is a magnetron source, may act simultaneously or alternately on the same substrate carrier 5 or the substrates placed thereon. As [the] a result, it becomes possible to deposit, for example, alloys while maintaining the initially mentioned requirements or other compounds while including the possibility of also sputtering reactively. [By means of the precise] Precise positioning of the substrate carrier 5 in the Z- and X-direction[,] allows for adjustment of source-specific coating characteristics[ can in this case be adjusted].

Figure 5 schematically shows another preferred embodiment of the sputtering source according to the invention. The magnetron source 1 and the substrate carrier 5 or substrates deposited thereon, in the machining position, close off a process space PR in that the substrate carrier 5 or a substrate itself are placed so far against side walls 22 of the vacuum chamber that the free rotating movement  $\omega$  is still ensured. For this purpose, as illustrated in Figure 5, the substrate carrier can not only be

[caused in a] driven [manner] to carry out the mentioned rotating movement  $\omega$  but can preferably also be lifted linearly into the machining position and be lowered from it. By the uncoupling of the process space P from other chamber parts, particularly with 5 movable parts, the particle contamination is reduced during the coating.

Figure 6 schematically shows a first embodiment of a vacuum treatment system according to the invention having at least one sputtering chamber 20 according to the invention. The sputtering chamber 20, together with the magnetron source 21, which, for maintenance purposes or for a target change, can be folded open as illustrated by a broken line, is flanged to a transport chamber 23. A transport device 27, which is rotationally movable about an axis of rotation B by [means of] a drive 25, operates in the transport chamber 23. One, two or more (see Figure 10) transport arms 29 with at least one component radial with respect to the axis B project to the outside from the axis of rotation B and each carry substrate carriers 31. As indicated by the double arrow F, the substrate carriers 31 can be moved out in a driven manner; in particular, can be moved into the machining position and be moved back therefrom, and further, as explained above, can be rotated in a driven manner about the axis A of the substrate carriers 31.

Analogous to the top view of Figure 6, Figure 7 is a top view of a system with several treatment stations, at least one of which being a sputtering chamber according to the invention.

5 Directly at the transport chamber 29 or via additional transport chambers, at least one lock chamber 33 is provided, [by means of which] whereby the substrates to be treated are transferred inward from the surroundings into the vacuum or are transferred outward from the vacuum into the surroundings. After being transferred inward, the substrates are fed [by means of] one or several transport devices, optionally after passing through additional treatment steps, to a sputter coating station according to the invention, such as station 21 of Figure 6.

10  
15 Figure 8, on the one hand, illustrates a transport chamber according to the invention, combined with a magnetron sputtering chamber of the above-mentioned type according to the invention, which together, on the other hand, form a system according to the invention.

20 Figure 9 is a sectional view according to Line II-II of the arrangement according to Figure 8. The combination of the transport chamber and the lock chamber to be described in the following with the above-described magnetron sputtering chamber

according to the invention results in an extremely compact system configuration with short transfer and transport cycles and, because of the sputtering chambers according to the invention, in coating cycles which are just as short.

5        The vacuum transport chamber 41 according to the invention has an interior 43 which, on the one hand, is bounded by a base plate 45 and, on the other hand, is bounded by a side wall structure 47 as well as a covering structure 49 situated opposite the base plate 45. The interior surface of the covering structure 49 can preferably be spaced away from the interior surface of the base plate 45 by a distance  $d$  which preferably is no more than identical to the thickness  $D$  of the base plate 45, preferably and as illustrated, even significantly smaller.

10      In the covering structure 49 of the transport chamber according to the invention, workpiece pass-through openings 51 are provided; in the case of the embodiment illustrated in Figures 8 and 9, two of such openings 51 being provided. Naturally, more than two of the above-mentioned openings 51 may be provided.

15      20      A transport device 57, whose currently preferable construction is illustrated particularly in Figure 9, operates in

the transport chamber according to the invention. Flanged laterally to the base plate 45 or to the side wall structure 47, a rotational axis hosing 51 is provided, wherein the driving axis of rotation 55 of the transport device 57 is disposed. The axis 5 of rotation 55 aligned perpendicularly to the interior surface of the base plate 45, in the illustrated preferred embodiment of the transport chamber according to the invention, carries a transport ladle 59 as the transport device 57[, which]. The transport ladle 59 has a stem 60 and a plate-type workpiece receiving 10 device 61. As illustrated in Figure 9, the transport ladle 59 is swivelled from a first swivelling position, in which the workpiece receiving device 61 is aligned with one of the two openings 51, into the second position illustrated by a broken line, in which the workpiece receiving device 61 is aligned with the second of the above-mentioned openings 51. As illustrated, the axis of rotation 55 of the transport device 57 is arranged 15 offset with respect to a connection line of the central opening axis  $Z_{51}$  entered in Figure 9. Furthermore, the openings 51 at the transport chamber according to the invention are situated so 20 close to one another that, as illustrated particularly in Figure 8, just enough space exists in-between, for - as will be explained in the following - arranging or flanging one machining station to one of the two openings.

As [the] a result of the above-mentioned position of the axis of rotation 55 as well as the minimizing of the spacing A of the openings (Figure 9), optimally short transport paths are implemented for the transport device 57, with swivelling angles  $\Psi$  of no more than  $120^\circ$ , preferably no more than  $90^\circ$ .

In the preferred illustrated embodiment, a lock chamber is integrated at one opening 51. One opening 51a is provided with a cover 65 which, as illustrated in Figure 8, can be swivelled in a motor-driven manner about a swivelling axis 67. This axis is preferably situated between the openings 51. The cover 65 seals off by[ means] way of sealing devices 69 against outer edge parts of the opening 51a on the covering structure 49[, which]. The sealing devices 69, in the closed state can optionally be braced by the linear motor cover drive which will be described [in the following] below.

Figure 8 illustrates the workpiece receiving device 61 in [an] alignment with the opening 51a as well as in an alignment with the additional opening 51, 51b. In the area of the opening 51a, a sealing arrangement is provided at the inner opening edge surface of the covering structure 49, preferably in the form of a hydraulically, [preferably] specifically pneumatically operable expandable seal 71, which is acted upon by pressure medium by way

of a connection piece 73. By the admission of pressure to the expandable seal 71, this seal 71 is sealingly pressed against the edge area of the workpiece receiving device 61. In order to absorb this peripheral stressing of the seal without any 5 distortion, the workpiece receiving device 61 abuts on the base plate side, particularly in its peripheral area. In the illustrated preferred embodiment, this abutting takes place by [means of] way another surrounding, hydraulically, but preferably pneumatically operable and expandable seal 75, which is acted 10 upon by pressure medium by way of one or several connections 77. As illustrated, the surrounding seals 71 and 75 may be situated opposite one another, in each case on inner base plate and covering structure surfaces, or may optionally be offset. In any case, they accommodate between one another, with the admission of 15 pressure, the workpiece receiving device 61 in a sealingly bracing manner.

The seal 75 closes off a remaining chamber volume 79 between the underside of the workpiece receiving device 61 and the interior surface of the base plate 45. This volume as well as 20 the actual lock chamber between the closed cover 65 and the peripherally sealed top side of the workpiece receiving device 61 is pumped down through a center opening 81 (see also Figure 9) on the workpiece receiving device 61 and a pump connection piece 83,

preferably centered with respect to the opening axis  $Z_{51}$ , on the base plate 45. For a further reduction of the lock chamber volume, the cover 65, as illustrated in Figure 8, is indented toward the workpiece receiving device 61 to such an extent that 5 its inner surface just barely does not touch a workpiece 85 held in the receiving device 61.

If the workpiece 85, as, for example, the storage disks, particularly the optical storage disks, is provided with a center opening, the reaching-through from the pump connection piece 83 to the lock chamber volume above the workpiece takes place unhindered through this center opening of the workpiece. If the disk-shaped workpiece is constructed without a center opening, (not shown) radial connection channels in the workpiece-facing surface of the workpiece receiving device 61 can improve this reaching-through, as, for example, a network of radial grooves.

10 The preferred, extremely compact vacuum treatment system illustrated in Figures 8 and 9 uses the transport chamber according to the invention with only just two openings 51, specifically openings 51a and 51b. While, as explained above, a 15 smallest-volume lock chamber is integrated at the opening 51a, a workpiece treatment station is flanged to the second opening 51b. 20 In the implemented form of the illustrated system [implementation

form], particularly for the sputter coating of circular-disk-shaped workpieces, particularly of storage disks, in this case, particularly of optical storage disks, the sputtering station 80 according to the invention is mounted on the opening 51b.

5        In this case, the central axis  $Z_s$  of the sputtering source 80 is sloped away from the other opening 51a such that the linear drive 83 for the swivelling movement of the cover 65 can be mounted on the mounting flange 82 for the inclined mounted sputtering source 80.

10        [On] In the illustrated sputtering system, a central part 84 can be lifted off the workpiece receiving device 61. On the base plate 45, a lifting and rotating drive 86 is mounted which is aligned with the axis  $Z_{51b}$ . If the workpiece receiving device 61 is centered in the opening 51b, by [means] way of the drive 86, as illustrated by [means of] letter F in Figure 8, [by means of] via the central part 84, the workpiece 85 in the machining position is lifted with respect to the sputtering source 80 and simultaneously, as illustrated by reference letter  $\omega$ , is caused to rotate.

20        In a preferred embodiment, the sputtering source 80 is mounted to be disposed swivellably about an axis 87, which axis

87, with respect to the opening 51b, is situated opposite the  
axis 67 of the cover 65 and is parallel thereto. As a result,  
[it is achieved that] the sputtering source 80 can be folded away  
without [an impairment of] impairing the cover drive 83 on the  
5 flange 82, as, for example, for servicing purposes or for  
replacing the target, as illustrated in Figure 8 by [means of]  
reference letter Q.

10 [By means of the] The transport chamber according to the  
invention and the vacuum treatment system according to the  
invention[,] achieve a highly compact, transport-path-optimized,  
constructively simple system and chamber [is provided] which  
permits a high throughput while highly uniform coating layer  
thicknesses are implemented. It is particularly suitable for the  
transport and the treatment of circular-disk-shaped workpieces,  
particularly for storage disks, and specifically for the  
15 treatment of optical storage disks.

20 [By means of] With a system according to the invention of  
Figures 8 and 9, substrates were coated, centered with respect to  
the substrate carrier axes, which substrates had diameters of 200  
mm and 240 mm. The following applied in this case:

Magnetron source: ARQ920G-source with an NiV7 round

target sold by the applicant

target diameter: 155 mm

sputtering power: 500 W or 1 kW

deposited layer thicknesses: 50 to 100 nm

5 target/substrate spacing (D): 100 mm and 140 mm

angle of slope  $\beta$  between the central axis of the source and the substrate carrier axis:

45°, 48° and 50°

argon pressure:  $2 \times 10^{-3}$  mbar

10 Use for master disks

In Figure 10, the coating results of the above-[mentioned coating]described example are compiled. They demonstrate the extremely good uniformity of the deposited layer thickness as well as its optimization by a slight change of the above-15 mentioned angle of slope  $\beta$ .

The foregoing disclosure has been set forth merely to  
illustrate the invention and is not intended to be limiting.  
Since modifications of the disclosed embodiments incorporating  
the spirit and substance of the invention may occur to persons  
5 skilled in the art, the invention should be construed to include  
everything within the scope of the appended claims and  
equivalents thereof.

[CLAIMS] WHAT IS CLAIMED IS:

1. Sputtering chamber having at least one sputtering source with a new sputter surface at least approximately symmetrical with respect to a central axis, [further having] a substrate carrier which is arranged to be drivingly rotatable [in a driven manner] about a substrate carrier axis, wherein the central axis and the substrate carrier axis [being] are oblique with respect to one another, [characterized in that] and the sputtering source is a magnetron sputtering source.

2. Chamber according to Claim 1, [characterized in that] wherein the new sputter surface is [essentially] substantially rotationally symmetrical with respect to the central axis.

3. Chamber according to [one of Claims 1 or 2, characterized in that] Claim 1, wherein the central axis and the substrate carrier axis intersect at least approximately.

4. Chamber according to [one of Claims 1 to 3, characterized in that the following applies] Claim 1, wherein, with respect to [the] an angle  $\beta$  between the central axis and the substrate carrier axis,

$$30^\circ \leq \beta \leq 60^\circ,$$

preferably

$$40^\circ \leq \beta \leq 55^\circ,$$

particularly preferably

$$43^\circ \leq \beta \leq 50^\circ,$$

particularly

$$\beta \approx 45^\circ.$$

5. Chamber according to [one of Claims 1 to 4, characterized in that] Claim 1, wherein the central axis and the substrate carrier axis have [their] a smallest spacing thereof at least approximately on a surface, which is to be sputter coated, of a substrate applied to the substrate carrier.

6. Chamber according to [one of Claims 1 to 5, characterized in that it can be arbitrarily positioned in the space, preferably in that] Claim 1, wherein the substrate carrier is configured to be positioned at least approximately horizontally.

7. Chamber according to [one of Claims 1 to 6, characterized in that the] Claim 1, wherein a projection of the new sputter surface onto a plane perpendicularly to the central axis is larger than the surface, which is to be sputter-coated and is projected on the same plane, of at least one substrate receivable on the substrate carrier.

8. Chamber according to [one of Claims 1 to 7, characterized in that] Claim 1, wherein at least two [of the above-mentioned] sputtering sources are provided [and can] to simultaneously affect a substrate.

9. Chamber according to [one of Claims 1 to 8, characterized in that] Claim 1, wherein the sputtering source has a new sputter surface which is [essentially] substantially rotationally symmetrical to the central axis, and[, in the operation, generates] is operable to generate in the sputtering surface at least one erosion trough which extends in a circular shape around the central axis, [in which case,] whereby the following relationship applies to the radius  $r_T$  of the site of the largest erosion depth of the radially outermost erosion trough and to the distance  $D$  of the site of the smallest spacing of the central axis and the substrate carrier axis from the sputtering surface,

$$1/4 \leq r_T / D \leq 2/3.$$

10. Chamber according to [one of Claims 1 to 9, characterized in that] Claim 1, wherein the new sputter surface is [essentially] substantially rotationally symmetrical with respect to the central axis, and the following relationship applies to the sputtering surface diameter  $\phi_T$  and the distance  $D$  between the sputtering surface and the site of the smallest

spacing of the central axis and the substrate carrier axis[ - preferably on the substrate surface to be coated],

$$3/4 \leq \varphi_T / D \leq 2,$$

preferably

$$\varphi_T \approx 1.2 D.$$

11. Chamber according to [one of Claims 1 to 10, characterized in that] Claim 1, wherein the substrate carrier is constructed [for the centered receiving of] to centrally receive at least one [or several substrates] substrate and[, for this purpose,] has a substrate receiving surface centered with respect to the substrate carrier axis, [in which case,] whereby the following relationship applies to the diameter of the receiving surface  $\varphi_s$  and to the distance D of the site of the smallest spacing of the central axis and the substrate carrier axis[ - preferably situated on the substrate surface to be coated -] from the new sputter surface,

$$\varphi_s / D \leq 1.8.$$

12. Chamber according to [one of Claims 1 to 11, characterized in that] Claim 1, wherein the new sputter surface is rotationally symmetrical with respect to the central axis and the substrate carrier is constructed [for the centered receiving of] to centrally receive at least one [or several substrates] substrate and[, for this purpose,] has a receiving surface

centered with respect to the substrate carrier axis, [in which case] whereby the following relationship applies with respect to the diameter of the substrate receiving surface  $\varphi_s$  and the diameter  $\varphi_T$  of the new sputter surface,

$$0.5 \leq \varphi_s / \varphi_T \leq 2.4.$$

preferably

$$1 \leq \varphi_s / \varphi_T \leq 2.4.$$

13. Chamber according to [one of Claims 1 to 12, characterized in that] Claim 1, wherein the substrate carrier has a centered receiving surface for at least one substrate with a diameter  $\varphi_s$  to which the following relationship applies,

$$50 \text{ mm} \leq \varphi_s \leq 400 \text{ mm},$$

preferably

$$50 \text{ mm} \leq \varphi_s \leq 300 \text{ mm}, \text{ and}$$

[in that] the diameter  $\varphi_s$  preferably amounts to

$$64 \text{ mm or } 120 \text{ mm or } 160 \text{ mm to } 240 \text{ mm.}$$

14. Chamber according to [one of Claims 1 to 13, characterized in that] Claim 1, wherein the substrate carrier is linearly drivingly displaceable [in a driven manner] in [the] a direction of the substrate carrier axis.

15. Chamber according to [one of Claims 1 to 14, characterized in that,] Claim 1, wherein in [the] a machining

position, a substrate arranged on the substrate carrier or the substrate carrier itself together with the sputtering surface bounds a process space on two sides thereof.

16. Vacuum treatment system having a least one sputtering chamber comprising at least one sputtering source with a new sputter surface at least approximately symmetrical with respect to a central axis, a substrate carrier which is arranged to be drivingly rotatable about a substrate carrier axis, wherein the central axis and the substrate carrier axis are oblique with respect to one another, and the sputtering source is a magnetron sputtering source, [according to one of Claims 1 to 16, characterized in that] wherein the sputtering chamber is connected by [way of] at least one [or several] transport [chambers] chamber with at least one lock chamber, in which substrates are [transferred] transferrable from [the] surroundings thereof into a vacuum and are [transferred] transferrable out of the vacuum into the surroundings.

17. Vacuum transport chamber for disk-shaped substrates, [characterized by] comprising:

[-] a base plate structure [(45)] [which, by means of its] having an interior surface[,] which borders [the] an interior [(3)] of the chamber on one side thereof,

[-] a covering structure which is situated essentially [in] parallel opposite [the] an interior surface of the base plate structure and which has at least two substrate passage openings which are adapted to [the] a substrate disk surface, and

[-] a transport device which is rotationally drivingly movable [in a driven manner] about an axis of rotation perpendicular to the base plate structure, in the chamber, with at least one substrate receiving device [which, by means of the rotating movement can] so as to be brought into [an] alignment [in each case] with a respective one of the openings, wherein a controlled sealing arrangement [establishing the] establishes an edge of at least one of the openings with the substrate holding device brought into [an] alignment [with it] therewith and a substrate provided thereon.

18. [Transport] Vacuum transport chamber according to Claim 17, [characterized in that] wherein one of the openings is equipped with a cover, [which can preferably be closed] closeable in a motor-driven manner with respect to [the] surroundings, whereby the cover and the workpiece receiving device brought into [an] alignment with [this] the one opening and a workpiece on [this] the respective receiving device forming interior-side and exterior-side lock valves for a lock chamber integrated at [this] the one opening.

19. [Chamber] Vacuum transport chamber according to Claim 18, [characterized in that] wherein the cover is configured to be indented toward the chamber for reducing [the] lock volume to be pumped down.

20. [Chamber] Vacuum transport chamber according to [one of Claims 17 to 19, characterized in that] Claim 17, wherein the sealing arrangement has at least one seal which extends on [the] an interior side of the chamber around an opening and [can be] is one of pneumatically [or] and hydraulically operated.

21. [Chamber] Vacuum transport chamber according to Claim 18, [characterized in that] wherein the sealing arrangement [has] comprises a seal which surrounds on the chamber side an opening provided with the cover and is one of pneumatically [or] and hydraulically operable, and an additional surrounding sealing arrangement [is provided which is] arranged opposite this seal on the interior basic plate structure surface and [can preferably be operated] is one of pneumatically [or] and hydraulically operable, [which] the two sealing arrangements [accommodate] accommodating in a sealing manner between one another the workpiece receiving device aligned with [this] the opening.

22. [Chamber] Vacuum transport chamber according to [one of Claims 17 to 21, characterized in that] Claim 17, wherein the

workpiece receiving device has at least one central opening[, preferably a central opening].

23. [Chamber] Vacuum transport chamber according to Claim 19, [characterized in that] wherein the cover is indented [so far] such that, in [the] a closed state thereof, [its] an interior surface thereof [just barely does not touch] is closely adjacent a workpiece disk on the workpiece receiving device aligned with the [mentioned] opening.

24. [Transport] Vacuum transport chamber according to [one of Claims 17 to 23, characterized in that] Claim 17, wherein two of the [mentioned] openings [are provided,] have centers with a connection line therebetween offset to the axis of rotation of the transport device [is arranged offset with respect to a connection line of the opening centers], and the workpiece receiving device, from [the] alignment with one of the openings to an alignment with the other of the openings, [carries] is configured to carry out a swivelling movement about the axis of rotation of not more than  $120^\circ$ [, preferably nor more than  $90^\circ$ ].

25. [Transport] Vacuum transport chamber according to Claim 24, [characterized in that] wherein the openings on the covering structure are separated [essentially only to] such [an extent]

that the flanging-on of a vacuum treatment chamber can take place in-between.

26. [Transport] Vacuum transport chamber according to [one of Claims 24 or 25, characterized in that] Claim 24, wherein the axis of rotation of the transport device is flanged laterally onto the base plate structure.

27. [Transport] Vacuum transport chamber according to [one of Claims 17 to 26, characterized in that] Claim 17, wherein at least one of a workpiece lifting drive and[/or] a workpiece rotating drive is mounted at at least one of the openings, opposite the covering structure [and preferably] in a centered manner with respect to [this] at least one opening, on the base plate structure.

28. [Transport] Vacuum transport chamber according to Claim 27, [characterized in that] wherein the workpiece receiving device has a central part which [can] is arranged to be lifted perpendicularly to [the] an interior base plate structure surface off the remaining transport device part connected with the axis of rotation, with which central part the at least one lift and[/or] rotating drive is then [brought in a controlled manner] controllably bringable into an operative connection when the

workpiece receiving device is aligned with the one opening [which has the above-mentioned] having the drive.

29. Vacuum treatment system having a vacuum transport chamber [according to one of Claims 17 to 28, characterized in that] comprising:

a base plate structure having an interior surface which borders and interior of the chamber on one side thereof,

a covering structure which is situated essentially parallel opposite an interior surface of the base plate structure and which has at least two substrate passage opening which are adapted to a substrate disk surface, and

a transport device which is rotationally drivingly movable about an axis of rotation perpendicular to the base plate structure, in the chamber, with at least one substrate receiving device so as to be brought into alignment with a respective one of the openings, wherein a controlled sealing arrangement establishes an edge of at least one of the openings with the substrate holding device brought into alignment therewith and a substrate provided thereon, wherein a vacuum treatment station is flanged at at least one of the openings onto the covering structure of the vacuum transport chamber.

30. System according to Claim 29, [characterized in that] wherein the station is [a] at least one sputtering source with a new sputter surface at least approximately symmetrical with respect to a central axis, a substrate carrier which is arranged to be drivingly rotatable about a substrate carrier axis, wherein the central axis and the substrate carrier axis are oblique with respect to one another, and the sputtering source is a magnetron sputtering source. [according to one of Claims 1 to 15].

31. System according to Claim 30, [having] further comprising a vacuum transport chamber [according to Claim 18, characterized in that] wherein one of the openings is equipped with a cover closeable in a motor-driven manner with respect to surroundings, whereby the cover and the workpiece receiving device brought into alignment with the one opening and a workpiece on the respective receiving device forming interior-side and exterior-side lock valves for a lock chamber integrated at the one opening, two of the openings are provided on the transport chamber, and the central axis of the sputtering source on one of the two openings is sloped away from the other opening, and [in that preferably] a motor drive for a cover is arranged at the other opening on a connection flange for the source.

32. System according to Claim 31, [characterized in that] wherein the cover is swivellably disposed on a swivel bearing

with a first swivelling axis [in] parallel [with respect] to the covering structure, which swivelling axis is arranged between the openings and [preferably] the source is [also] swivellably disposed about a second swivelling axis [in] parallel to the covering structure, which second swivelling axis, with respect to the opening provided with the source, is situated opposite the first swivelling axis of the cover.

33. Method for producing coated data storage disks or wafers, [characterized in that] comprising carrying out at least one coating step [is carried out] by an oblique-angled magnetron sputtering on to the rotating substrate.

34. Use of [the] a sputtering chamber [according to one of Claims 1 to 15,] having at least one sputtering source with a new sputter surface at least approximately symmetrical with respect to a central axis, a substrate carrier which is arranged to be drivingly rotatable about a substrate carrier axis, wherein the central axis and the substrate carrier axis are oblique with respect to one another, and the sputtering source is a magnetron sputtering source, having a [of the] transport chamber [according to one of Claims 17 to 28,] of [the] a system {according to one of Claims 16 and 29 to 32 and of the method according to Claim 33] wherein the sputtering chamber is connected by at least one transport chamber with at least one lock chamber, in which

substrates are transferrable from surroundings thereof into a  
vacuum and are transferrable out of the vacuum into the  
surroundings for [the] coating [of] optical data storage  
substrates, [of] masters, [or of] piezoelectric wafers or [of]  
wafers for [the] semiconductor production.

[Translation of Figure 8

	Gelenkkopf	joint head
	Gegenlager	abutment
	Schaltung Schleuse	switching of lock
5	Schnitt	section
	Zylinder	cylinder
	Schlitz	slot
	Sputterschutz	sputter guard
	Getriebemotor	transmission motor
10	Glas	glass

(the remaining words are illegible - translator)

Translation of Figure 10

	Schichtdicke	layer thickness
	Substratradius	substrate radius
15	$\phi_s / D \leq 1.8.$	]

## ABSTRACT

A sputtering chamber system and method uses at least one sputtering source with a new sputter surface at least approximately symmetrical with respect to a central axis. A substrate carrier is arranged to be drivingly rotatable about a substrate carrier axis. The central axis and the substrate carrier axis are oblique with respect to one another, and the sputtering source is a magnetron sputtering source. The new sputter surface is substantially rotationally symmetrical with respect to the central axis, with the central axis and the substrate carrier axis intersecting at least approximately. With respect to an angle  $\beta$  between the central axis and the substrate carrier axis,

$$30^\circ \leq \beta \leq 60^\circ,$$

preferably

$$40^\circ \leq \beta \leq 55^\circ,$$

particularly preferably

$$43^\circ \leq \beta \leq 50^\circ,$$

particularly

$$\beta \approx 45^\circ.$$

119

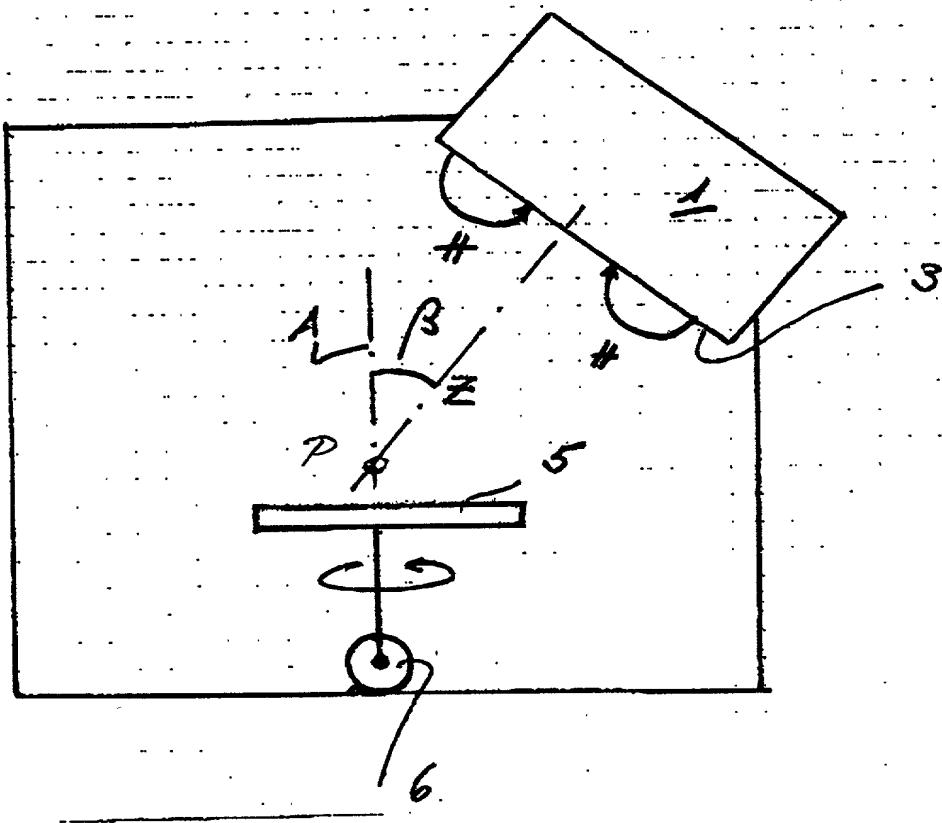
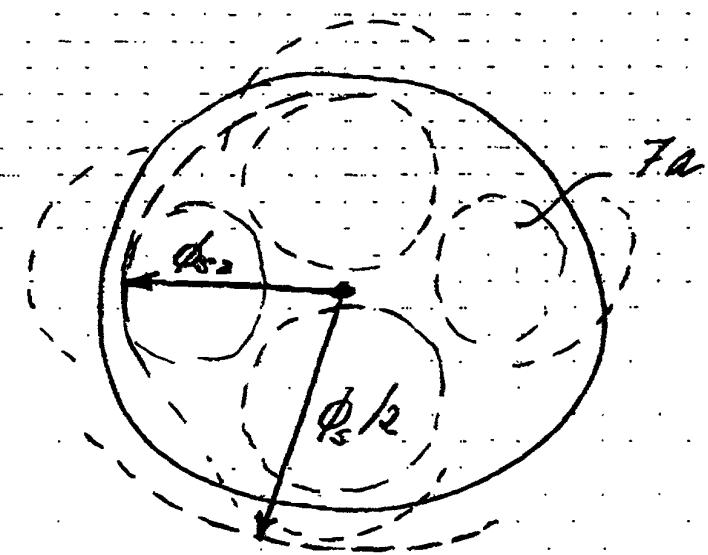
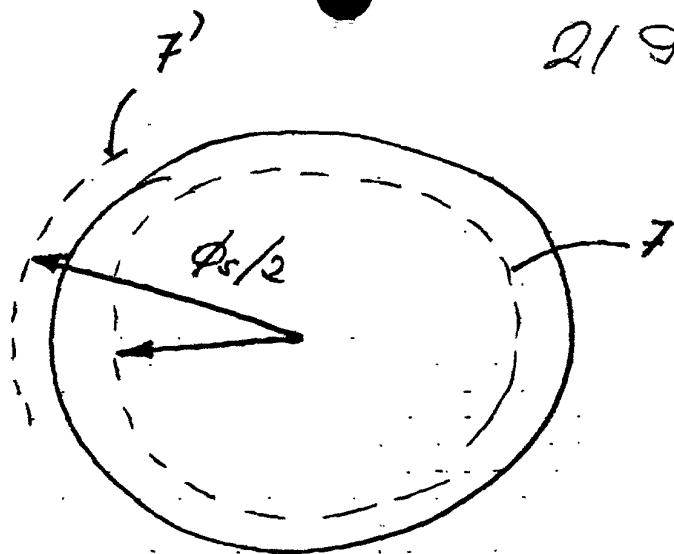
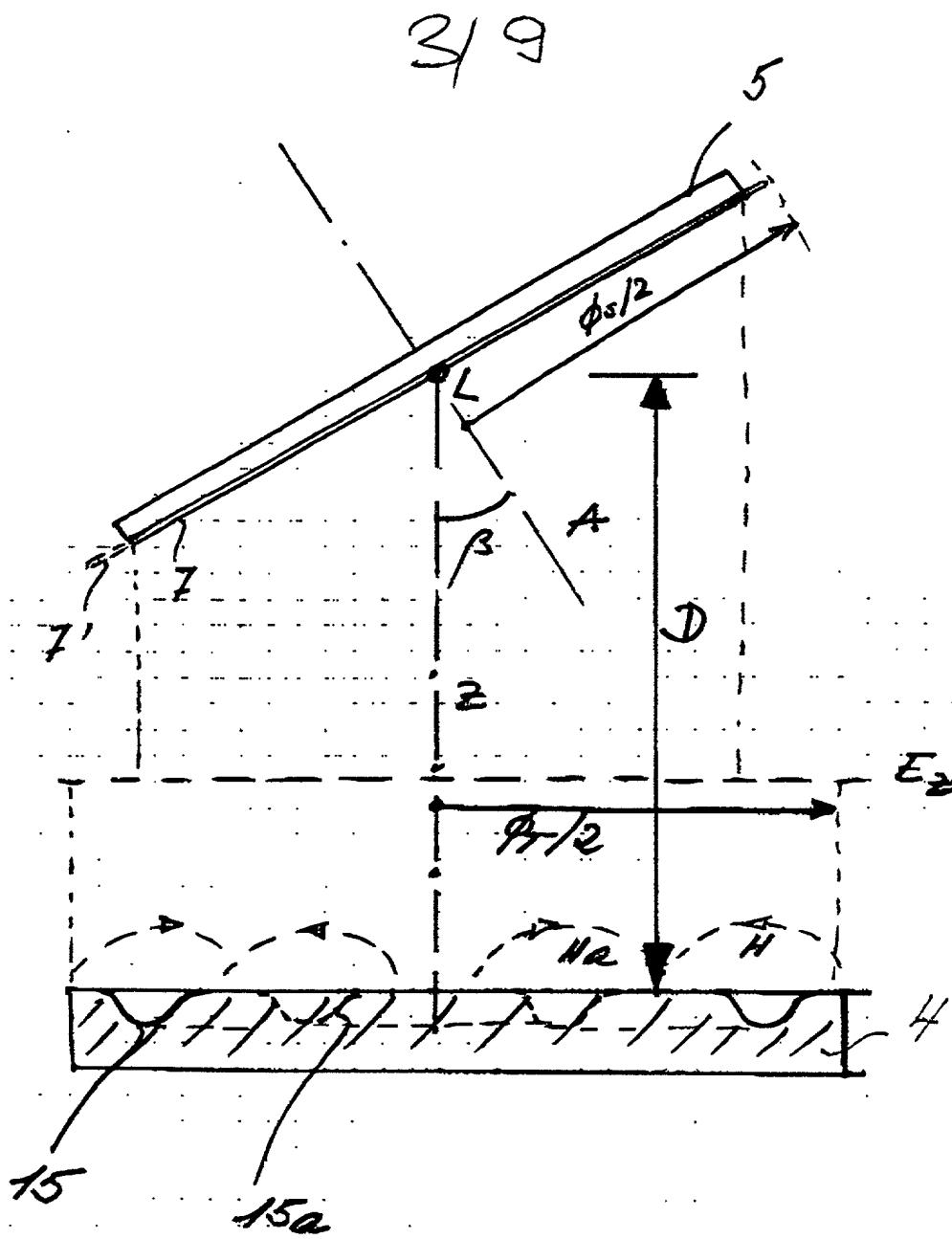


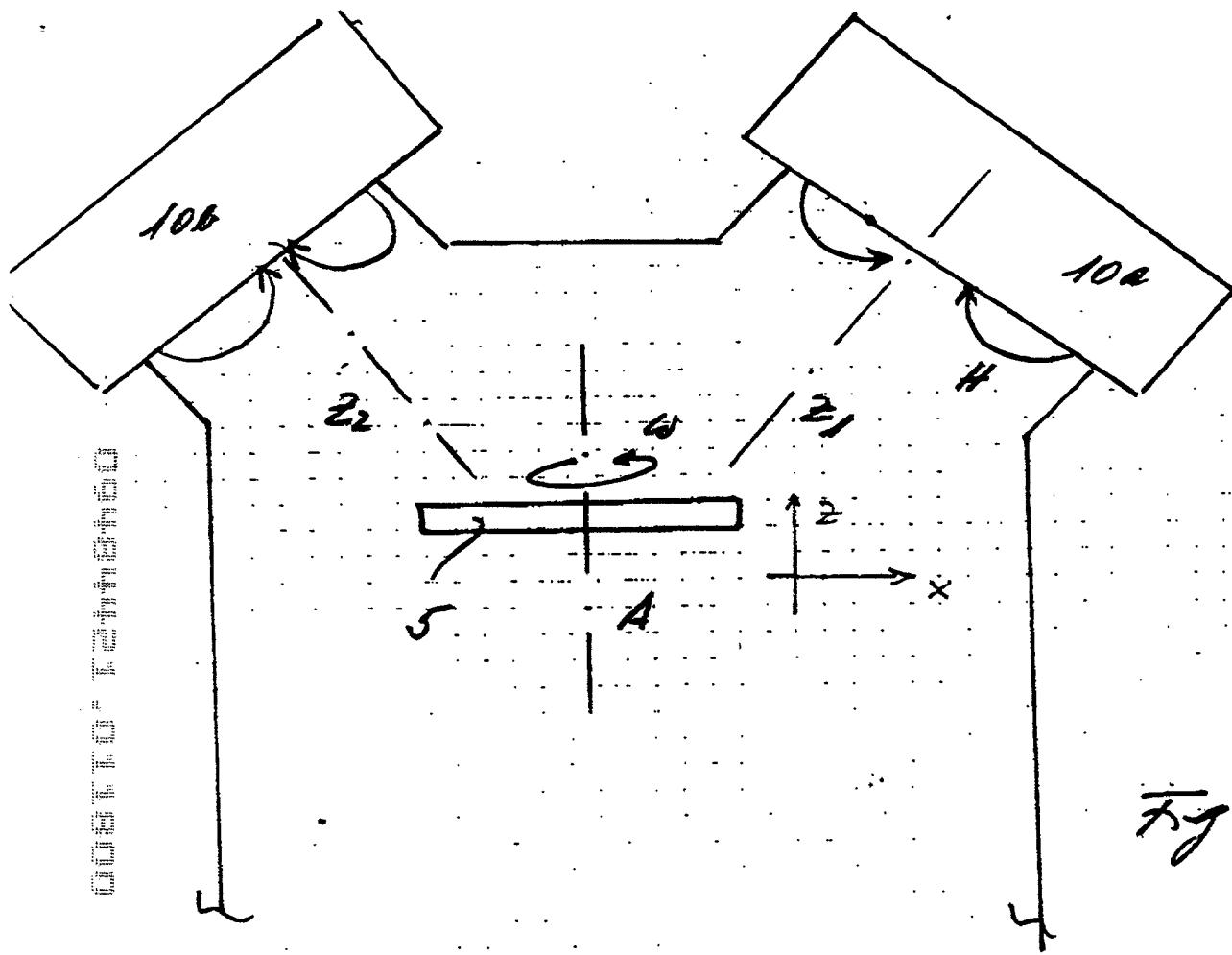
Fig 1

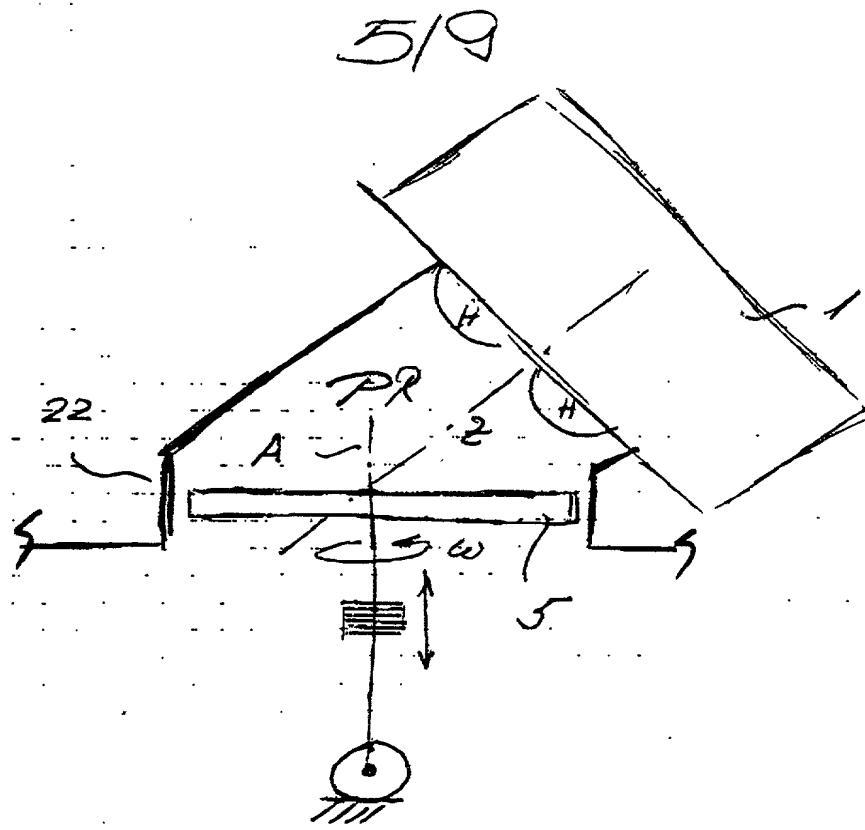


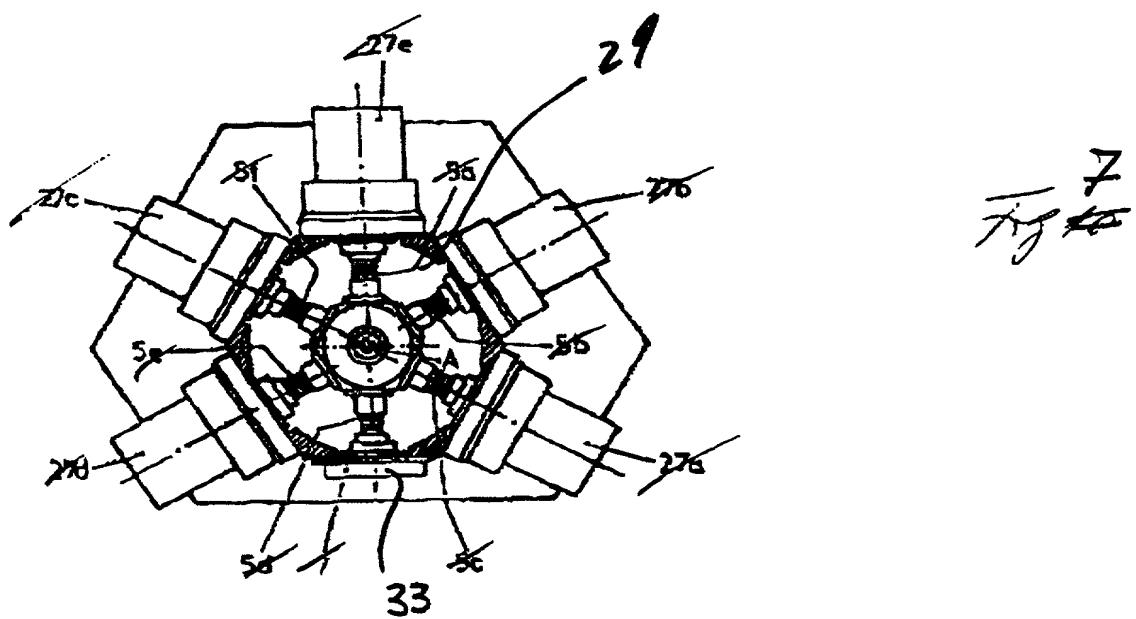
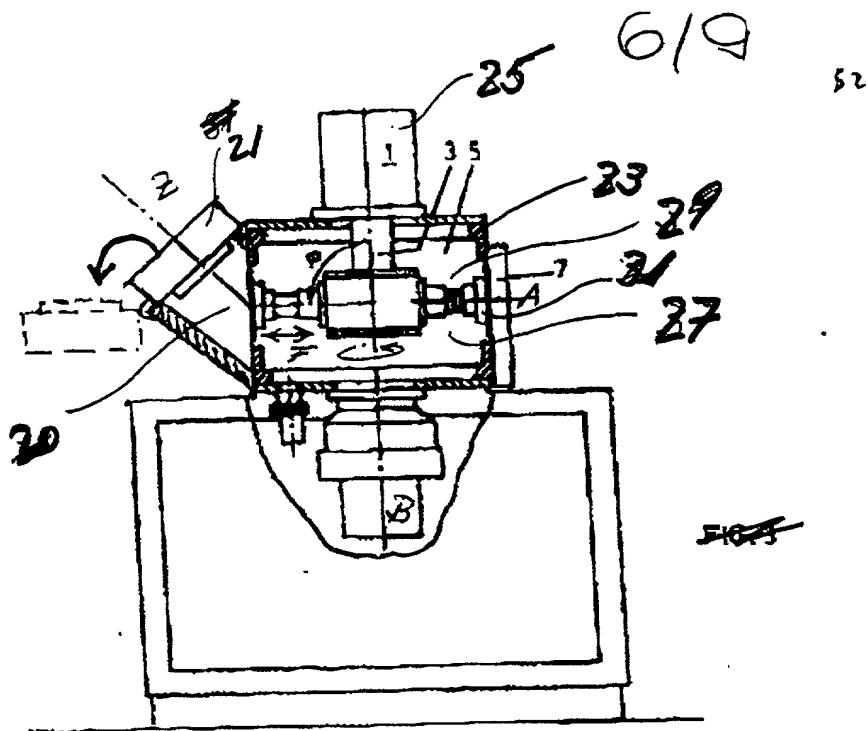


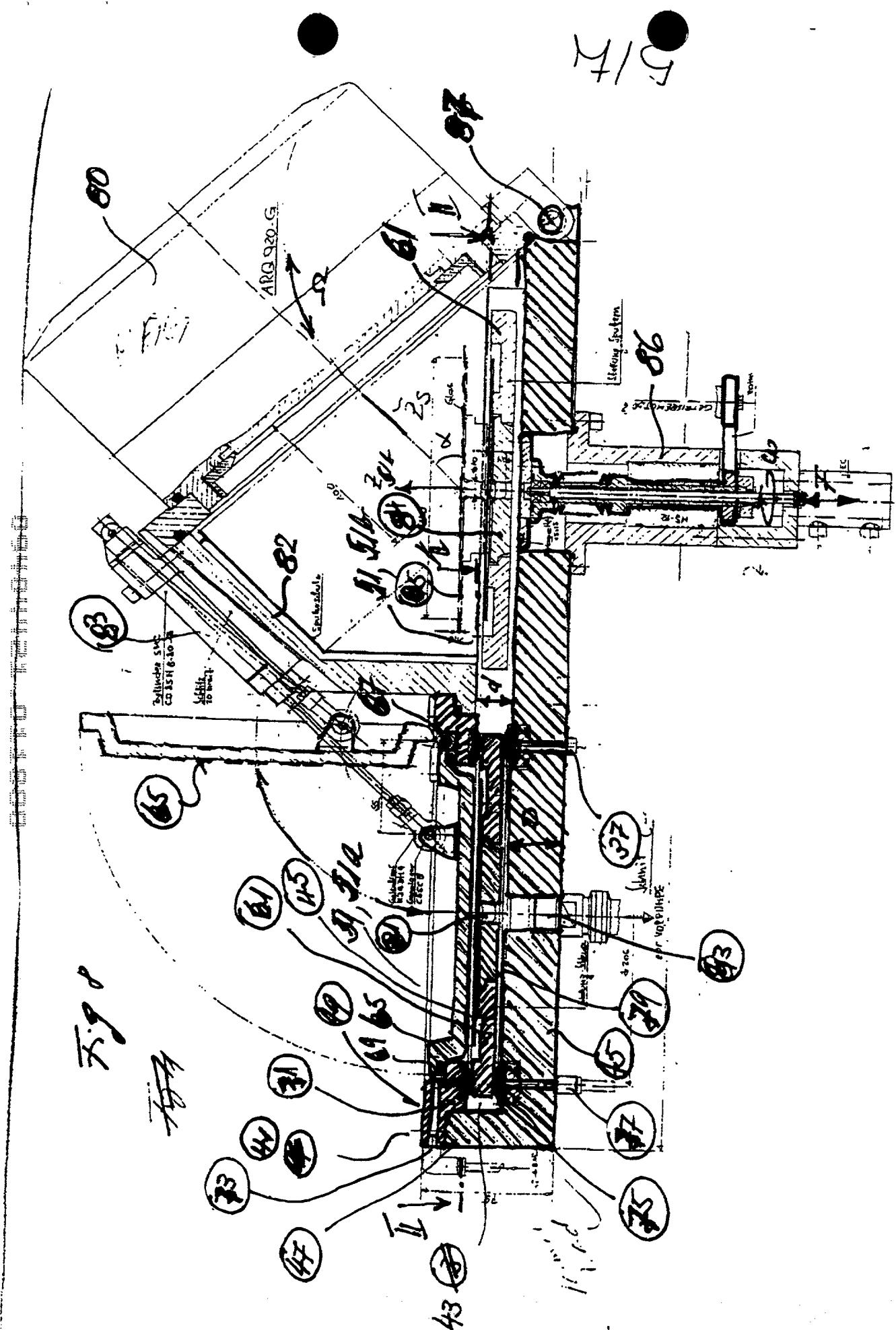
五·九·三

4/9









79.9

55.2

B

77

B

8/9

ARO 920-6

#52

77

77

77

54

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

6

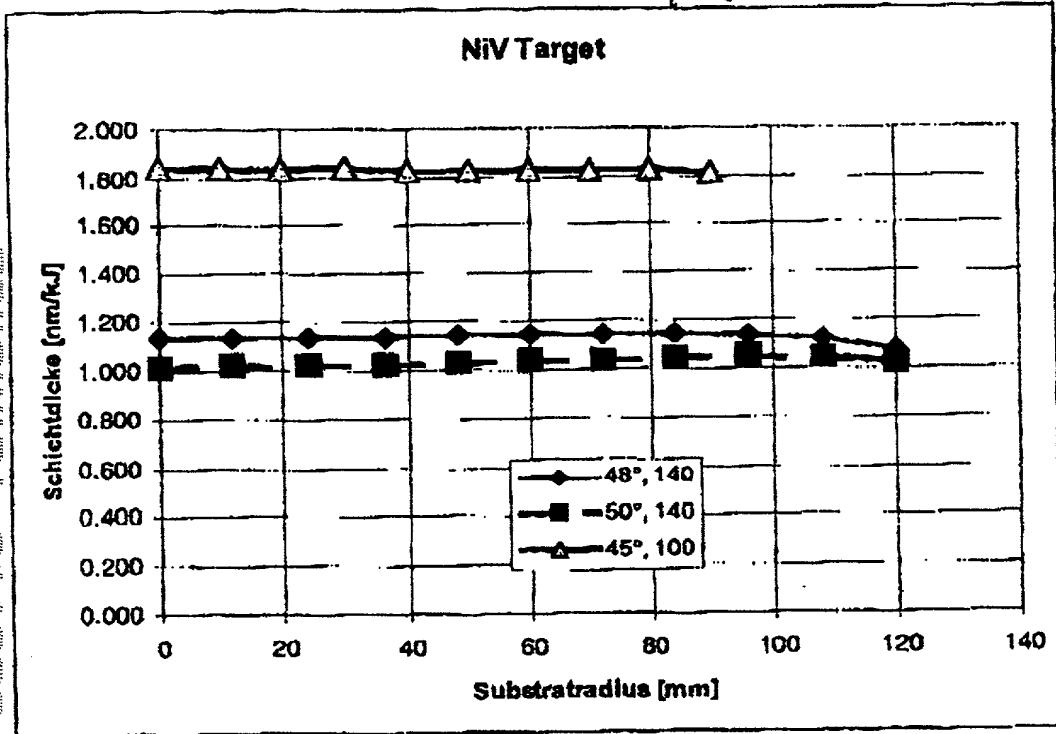
6

6

9/9

8

Fig 10



**DECLARATION AND POWER OF ATTORNEY - PATENT APPLICATION**

As a below named inventor, I hereby declare that my citizenship, postal address and residence are as stated below; that I verily believe I am the original, first and sole inventor (if only one inventor is named below) or a joint inventor (if plural inventors are named below) of the invention entitled:

**SPUTTER CHAMBER AS WELL AS VACUUM TRANSPORT CHAMBER AND  
VACUUM HANDLING APPARATUS WITH SUCH CHAMBERS**

the specification of which

X is attached hereto, or  
X was filed on January 18, 2000 as Application Serial No. 09/484,421 and  
was amended on \_\_\_\_\_ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above. I acknowledge the duty to disclose all information known to be material to patentability as defined in 37 CFR §1.56. I hereby claim foreign priority benefits under Title 35, United States Code §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

<input type="checkbox"/> Prior Foreign Application(s)	Priority Claimed
---	------------------

\_\_\_\_\_ (Number)

\_\_\_\_\_ (Country)

\_\_\_\_\_ (Day/Month/Year)

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose all information known to be material to patentability as defined in 37 CFR §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

\_\_\_\_\_ (Application Serial No.)

\_\_\_\_\_ (Filing Date)

\_\_\_\_\_ (Status)

I hereby appoint as principal attorneys Martin Fleit, Reg. No. 16,900; Herbert I. Cantor, Reg. No. 24,392; James F. McKeown, Reg. No. 25,406; Donald D. Evenson, Reg. No. 26,160; Joseph D. Evans, Reg. No. 26,269; Gary R. Edwards, Reg. No. 31,824; Jeffrey D. Sanok, Reg. No. 32,169; and Richard R. Diefendorf, Reg. No. 32,390, to prosecute and transact all business in the Patent and Trademark Office connected with this application and any related United States and international applications. Please direct all communications to:

**Evenson, McKeown, Edwards & Lenahan, P.L.L.C.**  
1200 G Street, N.W., Suite 700  
Washington, D.C. 20005  
Telephone: (202) 628-8800  
Facsimile: (202) 628-8844

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

**INVENTOR:** **Martin Dubs**

Citizenship: Swiss

Post Office Address/ Im unteren Stieg  
CH-7304 Maienfeld

Residence: Switzerland

May 25, 2000  
(date)

M. D. Dubs

(signature of 1st inventor)



DECLARATION AND POWER OF ATTORNEY

Attorney Docket No. 622/48561

Page 2

INVENTOR: Roman SCHERTLER  
Citizenship: Austrian  
Post Office Address/ Lorenz Schertlerstrasse 18  
Residence: A-6922 Wolfurt  
Austria

June 6, 2000  
(Date)

Roman Schertler  
(Signature of 2nd Inventor)